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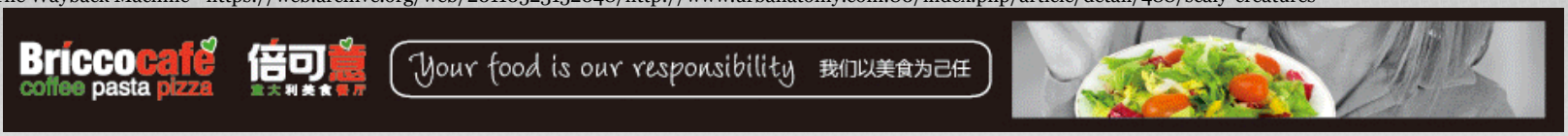

Scaly Creatures

by nickland @ Thursday, 05 May 2011 17:02

Cities are accelerators and there are solid numbers to demonstrate it

Among the most memorable features of Shanghai's 2010 World Expo was the quintet of 'Theme Pavilions' designed to facilitate exploration of the city in general (in keeping with the urban-oriented theme of the event: 'Better City, Better Life'). Whilst many international participants succumbed to facile populism in their national pavilions, these Theme Pavilions maintained an impressively high-minded tone.

Most remarkable of all for philosophical penetration was the Urban Being Pavilion, with its exhibition devoted to the question: what kind of thing is a city? Infrastructural networks received especially focused scrutiny. Pipes, cables, conduits, and transport arteries compose intuitively identifiable systems – higher-level wholes – that strongly indicate the existence of an individualized, complex being. The conclusion was starkly inescapable: a city is more than just an aggregated mass. It is a singular, coherent entity, deserving of its proper – even personal – name, and not unreasonably conceived as a composite 'life-form' (if not exactly an 'organism').

Such intuitions, however plausible, do not suffice in themselves to establish the city as a rigorously-defined scientific object. "[D]espite much historical evidence that cities are the principle engines of innovation and economic growth, a quantitative, predictive theory for understanding their dynamics and organization and estimating their future trajectory and stability remains elusive," remark Luís M. A. Bettencourt, José Lobo, Dirk Helbing, Christian Kühnert, and Geoffrey B. West, in their prelude to a 2007 paper that has done more than any other to remedy the deficit: 'Growth, innovation, scaling, and the pace of life in cities'.

In this paper, the authors identify mathematical patterns that are at once distinctive to the urban phenomenon and generally applicable to it. They thus isolate the object of an emerging urban science, and outline its initial features, claiming that: "the social organization and dynamics relating urbanization to economic development and knowledge creation, among other social activities, are very general and appear as nontrivial quantitative regularities common to all cities, across urban systems."

Noting that cities have often been analogized to biological systems, the paper extracts the principle supporting the comparison. "Remarkably, almost all physiological characteristics of biological organisms scale with body mass … as a power law whose exponent is

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typically a multiple of 1/4 (which generalizes to 1/(d +1) in d-dimensions)." These relatively stable biological features, such as metabolic rates, life spans, and maturation periods, to be anticipated confidence given body mass alone. Furthermore, they conform to an elegant series of theoretical nothing beyond the abstract organizational constraints of n-dimensional space:

"Highly complex, self-sustaining structures, whether cells, organisms, or cities, require close integ of constituent units that need efficient servicing. To accomplish this integration, life at all scales i space-filling, hierarchical branching networks, which grow with the size of the organism as uniqu self-similar structures. Because these networks, e.g., the vascular systems of animals and plants, energy is delivered to functional terminal units (cells), they set the pace of physiological processe size of the organism. Thus, the self-similar nature of resource distribution networks, common to basis for a quantitative, predictive theory of biological structure and dynamics, despite much exte and form."

If cities are in certain respects meta- or super-organisms, however, they are also the inverse. Meta organisms. As biological systems scale up, they slow down, at a mathematically predictable rate. as they grow. Something approximating to the fundamental law of urban reality is thus exposed:

The paper quantifies its findings, based on a substantial base of city data (with US cities over-repr 'scaling exponent' (or 'β', beta) that defines the regular correlation between urban scale and the f

A beta of one corresponds to linear correlation (of a variable to city size). For instance, housing s constantly proportional to population across all urban scales, is found – unsurprisingly – to have

A beta of less than one indicates consistent economy to scale. Such economies are found systema networks, exemplified by gasoline stations (β = 0.77), gasoline sales (β = 0.79), length of electric surface (β = 0.83). The sub-linear correlation of resource costs to urban scale makes city life incre metropolitan intensity soars.

A beta of greater than one indicates increasing returns to scale. Factors exhibiting this pattern in patents'β = 1.27, 'inventors' β = 1.25), wealth creation (e.g. 'GDP' β = 1.15, wages β = 1.12), but β = 1.23), and serious crimes (β = 1.16). Urban growth is accompanied by a super-linear rise in op interaction, whether productive, infectious, or malicious. More is not only better, it's *much* better worse).

"Our analysis suggests uniquely human social dynamics that transcend biology and redefine meta Open-ended wealth and knowledge creation require the pace of life to increase with organization institutions to adapt at a continually accelerating rate to avoid stagnation or potential crises. Thes generalize to other social organizations, such as corporations and businesses, potentially explain necessitates an accelerating treadmill of dynamical cycles of innovation."

Bigger city, faster life.

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